

The Mongolian Diaspora? C.J. KOLMAN, Dept. of Anthropology, Univ. of Florida, Gainesville, FL, 32611, J. LONG, Laboratory of Neurogenetics, NIAAA, N. SAMBUUGHIN, L. GOLDFARB, Clinical Neurogenetics Unit, NINDS, National Institutes of Health, Bethesda, MD 20892

Asia is the only continent with connection to all other inhabited continents, permitting the possibility of long-term contact with populations in these regions. Genetic and archaeological data suggest that Asian populations have been influential at several critical periods in human evolution including the dispersal of anatomically modern humans and the colonization of the New World and the Pacific Islands. However, relatively little research has been conducted on Asians, particularly those populations from Central and Northern Asia.

An understanding of the origin and evolution of Asian populations is particularly relevant to reconstructing the colonization of the New World. Recent data suggest that Mongolians represent the closest genetic link between the Old and New World. Furthermore, a growing body of evidence supports the view that Mongolians may have retained the greatest similarity to the founding population that colonized a major portion of the Asian continent in addition to the New World.

We have assayed DNA polymorphisms at select nuclear loci in Mongolian (n=25), Siberian (n=25), Chinese (n=33), Amerind (n=126) and Na-Dene (n=60) populations in order to gain a better understanding of the evolution of Asian populations and the New World colonization process. Loci were chosen whose alleles showed distinct distributions between Asian and Asian-derived populations and populations were chosen to most accurately represent Asia and the New World. Alleles of alcohol dehydrogenase and aldehyde dehydrogenase exhibited frequencies in Mongolian and Siberian populations that were intermediate between those of Chinese and New World populations. Mongolians and Siberians also carried a haplotype of the downstream region of *MX1* that was present in New World populations but absent in those from East Asia. These results suggest that Mongolians represent a group central to our understanding of colonization events throughout Asia and the New World.

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Bayesian forensic anthropology. L.W. KONIGSBERG and A.H. ROSS, Department of Anthropology, University of Tennessee, Knoxville, TN 37996.

Physical anthropologists are often faced with a choice between maximum likelihood estimators that start from an uninformative prior distribution and Bayesian estimators that start from an informative prior. In forensic anthropology there frequently is prior information external to the osteological evidence, and as a consequence, Bayesian estimators are extremely useful. In this paper we give examples of common forensic anthropology problems that can be addressed using Bayesian approaches, and show how modern computer

methods allow for relatively easy application of Bayesian methods.

One of the simplest Bayesian approaches, and the one with which most physical anthropologists are familiar, is the use of an informative prior in discriminant function analysis. As an example, in a two-group setting, the log posterior odds are equal to the log-likelihood ratio plus the log prior odds. We give an example from craniometric sexing, where we first take an uninformative prior, and then adjust the prior to represent increasing belief that the individual is one sex as versus the other.

A more complicated example of Bayesian forensic anthropology comes from stature estimation. Traditionally, forensic anthropologists have regressed stature on one or more bones to estimate stature for new cases. Although this is an inherently Bayesian approach, it may use the wrong prior if the new case comes from a stature distribution which is markedly different from the reference sample. We show how a normal distribution for stature that is specific to the population from which the forensic case was drawn can be used as a conjugate prior in stature estimation.

One of the most complicated applications of Bayesian forensic anthropology is in the estimation of age at death. Here the prior distribution for age does not form a conjugate prior. It is consequently necessary in finding the posterior density for age to either integrate numerically across age at death, or approximate the integral using Monte Carlo methods. We show the relative ease of the latter approach.

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Four catarrhine crania from Rudabánya. L. KORDOS, The Geological Museum of Hungary, H-1143 Budapest, Stefánia út 14, and D.R. BEGUN, University of Toronto, Toronto, ON, M5S 3G3, Canada.

Since 1965 the recovery of fossils at the late Miocene locality of Rudabánya, Hungary, has produced 171 primate specimens, including four relatively complete crania of two different catarrhines. Three are attributed to *Dryopithecus brancoi* (RUD 44, RUD 77, RUD 200) and one to *Anapithecus hernyaki* (RUD 83). RUD 83 differs in many characters from the known cranial material attributed to the pliopithecids. It is larger than the crania of *Epipliopithecus vindobonensis* and *Laccopithecus robustus* from Slovakia and China respectively, and close in size to the crania of siamangs, but the mixture of morphological attributes makes attribution to any known fossil catarrhine family ambiguous. On the other hand, the three *Dryopithecus* specimens are diagnostically hominid and reveal considerable amounts of information on cranial diversity in this taxon. The females RUD 77 and RUD 200 are both considerably smaller than the male (RUD 44), but RUD 200 is exceptionally small in both cranial and dental dimensions. Nevertheless, the size ratio of the smallest and largest homologous teeth at Rudabánya, while high, do not exceed MI values reported in Martin and Andrews (1994). This index fails to falsify the single species hypothesis for this sample, though it is

susceptible to type 2 errors. We conclude for now that one species is represented. All three *Dryopithecus* crania preserve much of the periorbital region, two preserve most of the neurocranium (RUD 77 and 200) and two preserve nearly complete palates (RUD 44 and RUD 200). While variable in their details, these crania all share characters of the palate, face, orbits, neurocranium and basicranium with African apes and humans. The newest specimen, RUD 200, is also the most complete and confirms interpretations of the African ape-like overall cranial morphology based on less complete specimens, particularly with regard to neurocranial morphology and craniofacial hafting.

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Anterior myodural bridge in the cranio-spinal space: a reciprocal relation with the posterior myodural bridge. R.T.Koritzer and R.R.Harris, Baltimore College of Dental Surgery, Dental School, University of Maryland at Baltimore.

In dissections exposing the anterior cranial-spinal space, a dense connective tissue (CT) attachment between the rectus capitis anterior muscle and the spinal dura was found. Tension applied to this CT caused flexion of the dura. This relation may be termed a myodural bridge in keeping with the previously reported posterior myodural bridge.

In the earlier study, the rectus capitis posterior minor muscle was found in a similar relation of CT and dura. This posterior relation was postulated as a potential source of cranio-occipital headache.¹

The initial report seemed to leave a "dangling" force. This stimulated us to search for an anterior reciprocal for this posterior myodural bridge.

The dissections were done over several years using hemisected heads provided by the Maryland Anatomy Board most of which had first been used in student dissections but not involving our area of interest. Facilities were provided by The Maryland Dental School. The total number of dissections exceeded 30.

Histologic stains done at the private pathology laboratory of Mr. John Murdock for serial section confirmed the gross dissection results. Examination of the muscle, CT, dura microanatomy included observation of fiber orientation and density. This provided information about force magnitude and directionality.

Because of the proximity of the spinal nuclei related to cranial nerves, implications for possible force triggering are tempting considerations. Such effects, however, await physiologic studies in the light of these newly described anatomic structural relations. One may be curious about the association of trigeminal and vagal symptoms concomitant in some cranial-cervical-mandibular pain dysfunction patients.

1. G.Hack, R.T.Koritzer et al Anatomic relation between the rectus capitis posterior minor muscle and the dura mater. Spine 1995;20: 2484-2486.

Assessing the efficacy and pragmatism of "race" designations in human skeletal identification: A test of the FORDISC 2.0 program. S. KOSIBA, Department of Anthropology, University of South Florida. Tampa, FL 33620.

This study concentrates on intra-populational skeletal variation, and the concomitant limitations of forensic anthropology in assessing geographic ancestry using fixed and generalized "racial" types in light of distinct local variation. As ancestry assessment is crucial to the identification of skeletal remains, forensic anthropologists encounter the dilemma of how to disavow the existence of "races" in a biological and evolutionary context while applying the concept to human remains in a medico-legal context. The biological concept of "race" is a misrepresentation of the reality of human variation; its application to skeletal remains for the purpose of identification can therefore be misleading and erroneous.

A series of skeletons known to have been obtained from India were assayed macroscopically and metrically. FORDISC 2.0 (Jantz and Ousley, 1996) was employed in order to assess whether the discriminant functions of the program, being based on broad demographic groupings, would consistently classify this population in terms of sex and geographic ancestry. Conclusions from the macroscopic analyses were compared with those from FORDISC 2.0.

The resulting FORDISC 2.0 classification remained inconsistent within the sample. Moreover, the program often assigned notably low typicality probabilities (< .05) to the remains, suggesting a questionable or anomalous designation within the particular category. These data are posited as being inconclusive due to the program's use of broad demographic and "racial" categories which may impede accuracy when classifying individuals from populations with a large amount of intra-regional variation. Such generalizations belie the significance of distinct morphological characteristics within local populations. Alternatively, these characteristics could be used as identification tools through the comparison of unidentified skeletal remains to known intra-populational variants.

Tetracycline labeling and bone preservation in ancient Nubian populations. M. KRAFFELD-DAUGHERTY and G.J. ARMELAGOS. Department of Anthropology, Emory University, Atlanta, GA 30322.

Piepenbrink and coworkers have argued that most of the tetracycline labeling that was reported in ancient Nubian bone is in fact due to post-mortem changes. They claim that soil organisms such as *Strachybotrys* can invade and destroy bone and leave a tetracycline-like fluorescence as a

result of taphonomic changes. Even though we dealt with the possibility for post-mortem diagenesis in our original publication, we reevaluated the possibility of diagenesis in light of the persistence of their arguments.

Our chemical and histological analyses have confirmed our original hypothesis. In vivo incorporation of tetracycline with subsequent deposition of a permanent, discrete fluorescent label in the bone is now firmly established. The pattern of fluorescence was identical to tetracycline labeling that is incorporated during life (in vivo), and very different than post-mortem mold infestation produced in the test tube (in vitro). In the small percentage of bones that do show taphonomic destruction, we can distinguish post-mortem changes from in vivo incorporation of tetracycline. Selections were specifically stained with haematoxylin attesting to the state of preservation of the organic portion of the bone and there is little evidence of deterioration at the cellular level. Thin sections examined under polarized light confirm this interpretation

1999 Excavations in the Rancah District, West Java, Indonesia. A. KRAMER, J.M. ELAM, Department of Anthropology, University of Tennessee, Knoxville, TN 37996, T. DJUBIANTONO, Archaeological Research and Development Center, Bandung, West Java, Indonesia, F. AZIZ, Quaternary Geology Laboratory, Bandung, West Java, Indonesia and W.E. HAMES, Department of Geology, Auburn University, Auburn, AL 36849.

During the summer of 1999, Kramer and Djubiantono directed multidisciplinary field excavations and surveys in the Rancah district of West Java, Indonesia. At two sites along the Cipasang and Cisanca Rivers, our team excavated approximately 50 m² of deposit to a depth of 7 m. We recovered numerous large vertebrate fossils from both excavations and from surface surveys of the surrounding areas. Aziz is undertaking the identification of these faunal elements. At Cipasang, we exposed, sampled, and brought back to the USA, three air-fall tuffs that are being dated by Hames using laser ⁴⁰Ar/³⁹Ar methods. At Cisanca, we recovered bovid teeth that Elam is subjecting to ESR analyses.

Our most significant discovery was a hominid incisor found *in situ*, 353 cm below the surface at Cisanca. This is the first fossil hominid recovered from West Java and one of the very few Indonesian hominids to be produced as the result of a controlled excavation. Unfortunately, unlike at Cipasang, there were no tuffs preserved at Cisanca.

Therefore, we are attempting to ascertain the age of the hominid tooth by the following methods. First, the ESR dates derived from the underlying bovid teeth should provide a maximum age. Secondly, chemical correlations between the fine-grained blue sandstone from which the tooth was recovered and the lithologically-similar, vertebrate fossil-bearing layer at Cipasang are being investigated by neutron activation analyses (NAA) of both strata. Finally, paleoenvironmental correlations of the two layers are being evaluated by palynological analyses.

The success of this project encourages us that future fieldwork in the area (slated for summer 2001) may reveal the timing of Southeast Asian hominid origins.

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Exploring the Locomotor System of a Biped through a Behavioral Ecology and Life History Perspective.

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One of the cornerstones of modern evolutionary biology is the insight that an individual that is more tailored to his environment should have a higher survival and reproductive potential than his less adapted neighbors. Behavioral ecology attempts to explain behaviors as adaptive—or not—only in particular ecological contexts. And life history theory highlights that the developmental stage of an individual is an integral part of their environment and that development is an inherently sequential process. But how do these seminal ideas help us understand the evolution of hominid bipedality?

Bipedality can be thought of as a suite of possible styles, with different forms optimizing diverse traits. The locomotor form of an individual can be optimized for many characteristics, including 1) efficient use of energetic, thermal, temporal and water budgets; 2) range; 3) velocity or acceleration; 4) endurance, fatigue and injury protection; and 5) burden carrying. All could be important in different ecological circumstances and, indeed, many may act in concert with others, but which ones? when? how? and how can we tell from the fossil record?

While female australopithecines appear to have excelled at slow speeds and short distances, the locomotor form of *Homo* seems to be oriented toward relatively long distance travel and endurance walking and running. Understanding these aspects of the locomotor regime does not, however, inform about the other elements of the behavioral repertoire, nor does it elucidated why did the transition took place and what the functional implications of it are.

The task of understanding bipedality as a fundamental adaptation of Hominidae can only be a truly fruitful endeavor if we keep in mind that males and females may have different ecological perspectives; children, adolescents, and adults may

interact with the environment in different ways; and the environment is a complex set of interacting, dynamic factors.

The Kazartepe from Miletus - A necropolis for Hellenistic athletes?

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During several excavations, starting in 1901 and finishing in 1996, 280 skeletons, for the most part strongly fragmented, were found in the Hellenistic-Roman necropolis (4th century BC - 1st century AD) situated on the Kazartepe, near the antique Miletus (Turkey). From the archeological and anthropological point of view, the buried individuals represent a population of above average class. This is indicated by the distribution of age and sex, the strong sexual dimorphism and the good health and nutritional condition of the macroscopically examined skeletons.

The necropolis of Kazartepe contains, for the most part, male individuals (approximately 70%). Only 10% of the cases are subadults. The average age of the male individuals is 53 years, for the female individuals it is 51 years. These results are superior to findings from comparable Hellenistic-Roman cemeteries.

The postcranial parts of the skeletons indicate a remarkable sexual dimorphism. The long bones of male individuals are highly robust with very strong muscle attachments; the long bones of the female individuals show only slight signs of muscle attachments and are very delicate. It is evident that there must have been different physical activities for men and women.

The male individuals show extremely strong muscle attachments, especially on the lower and upper limbs and the crista iliaca, indicating well developed and intensely used muscles of the locomotor system.

The findings lead to the following hypothesis:

For the most part the men from Kazartepe could have been professional athletes, who trained hard over a long period to build up muscular substance. There is proof for extremely strong muscle attachments on certain long bones, a series of specific alterations to the skeletons, such as degenerative changes of the vertebra column and the joints, fractures of the tibia and intravital loss of the frontal teeth.

The demands and injuries well known from special types of martial arts, like fist fights and pancratia, are plausible causes for the numerous pathological changes that were found in the excavated male skeletons.

Human paleodiet, carbon isotopes, and the canopy effect: Documenting the Neolithic in tropical Southeast Asia using tooth enamel apatite. J.S. KRIGBAUM, Department of Anthropology, New York University, New York, NY 10003.

Studies of prehistoric human subsistence in the Southeast Asian tropics have been few, in part due to poor

preservation of organics. To circumvent this problem, stable isotope ratio analysis has been applied to tooth enamel apatite, a biogenic mineral less prone to diagenesis than bone. Stable isotopic methods using enamel are well-established, and allow quantitative correlation between diet and consumer tissues.

Two archaeological sites in present-day Malaysia are the focus of this study. Niah Cave's West Mouth, in northern Borneo (Sarawak), has produced an extensive late Pleistocene - Holocene (Epi-Paleolithic and Neolithic) assemblage. Gua Cha, on the Malay Peninsula (Kelantan), is a rock shelter with remains from Hoabinhian and Neolithic contexts. Both sites are presently situated in C₃-dominated rain forest habitat. They are, however, both geographically and culturally disparate.

¹³C/¹²C ratios range in value from ca. -16 to -11 ‰, a fair degree of $\delta^{13}\text{C}$ variation for broad spectrum C₃-based foragers. The pre-Neolithic pooled sample show more negative $\delta^{13}\text{C}$ values (N=19, \bar{x} = -14.5 ‰) compared to the pooled Neolithic sample (N=32, \bar{x} = -13.2 ‰). These differences are statistically significant (Student's t-test) at the .01 level. The shift is quite marked at Gua Cha, where Hoabinhian remains (N=4; \bar{x} = -15.3 ‰) are on average 2 ‰ more negative than Neolithic remains (N=4; \bar{x} = -13.1 ‰). Niah Cave shows similar trends, however, with increased variation in $\delta^{13}\text{C}$ values by burial "type."

The Neolithic shift in $\delta^{13}\text{C}$ may be a result of increased consumption of ¹³C-enriched C₃ plants grown in open forest conditions. Recent research on the "canopy effect" and $\delta^{13}\text{C}$ variation in C₃ plants support this interpretation. The canopy effect is a phenomenon of closed forest habitats whereby ¹³C is increasingly discriminated against from top canopy to forest floor. Since C₄ grasses at both sites are likely insignificant, it is hypothesized that the positive $\delta^{13}\text{C}$ shift is a product of forest clearing and cultivation of C₃ crops, including rice (*Oryza sativa*).

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Cross-Sectional Geometric Properties of the Distal Tibial Metaphysis in Humans and Apes. C.A. KUNOS and B. LATIMER, Department of Anatomy, Case Western Reserve University and Laboratory of Physical Anthropology, Cleveland Museum of Natural History, Cleveland, OH 44106.

As a consequence of an extended hip and knee, a biped's lower limb engenders impact loads at heel strike that may potentially damage articular cartilage. Unlike quadrupedal mammals, hominids have forfeited eccentric muscular contraction in the forelimb as a means for dissipating these dangerous peak loads. Instead, hominids have adopted a unique anatomical distribution of bone taking advantage of this material's viscoelastic properties. Alterations in cortical and cancellous bone distribution, proportion, and orientation have provided humans and their ancestors a novel metaphyseal structure—one that allows elastic deformation of metaphyseal bone while simultaneously minimizing structural failure.

In mammals, the first role of bone is structural support. Indeed, cortical bone becomes stiff rapidly when loaded

under high impact load. Conversely, cancellous bone is much more compliant. When compared to African apes, human tibiae demonstrate a relatively thin cortical margin, an expanded metaphyseal radius, and an expanded cancellous volume, and thereby, a reduced apparent density of the metaphysis. Since elastic modulus increases with the cube of the apparent density, any reduction in apparent density would act to increase the energy storage capacity of the distal tibiae. In other words, work performed on the distal tibia during bipedal heel strike is proportional to the volume of the tibial metaphysis.

In this way, humans have adapted the ends of long bones to mitigate potentially damaging impact loads while simultaneously providing structural support. The presence of similar expansions of metaphyseal volumes in *A. afarensis* and *A. anamensis* further confirms a dramatic commitment to terrestrial bipedality early in our species' evolutionary history, and thus, suggests that these adaptations may be included among the earliest skeletal features associated with a habitual bipedal gait.

On reported differences between histological and radiological studies of tooth calcification in chimpanzees. K.L. KUYKENDALL, Anatomical Sciences, University of the Witwatersrand, Johannesburg, South Africa 2193.

Evolutionary models of early hominid life history rely heavily on comparative data describing dental development in modern and fossil hominoids and hominids. Analysis of fossils in this regard relies on an opportunistic strategy involving both radiographic and histological techniques. However, recent research indicates that different approaches produce fundamentally dissimilar results, impeding direct comparison of histological and radiological estimates of developmental status. One major problem is that histological assessment produces data akin to longitudinal chronologies of tooth calcification in individuals, while radiographic studies are aimed at producing population standards from much larger samples.

Beynon et al. (1999) showed that radiographic assessment, in contrast to histology, is incapable of accurately detecting either initial crown calcification or crown completion. Thus, Reid et al. (1999) published estimates for crown formation periods, from a small histological sample of chimpanzees, that were as much as 3.1 years longer than indicated by radiographic studies.

Reid's estimates for radiography are based on published mean ages. This brief analysis is a comparison of the published age ranges for crown initiation ages, crown completion ages, and crown calcification periods in radiographic and histological studies of chimpanzee tooth calcification. The aim is to determine whether sampling and analytical methods might contribute to the differences Reid reported, in addition to practical techniques.

It was found that the histological age ranges for initial crown formation encompass younger ages, and those for crown completion encompass older ages compared to radiographic estimates for most teeth, but all ranges overlap considerably. Thus, histological data do tend to describe

longer periods of crown formation as noted by Reid. However, crown formation periods estimated from age ranges only differ by a maximum of 1.14 years, and Reid's calculations may over-estimate such differences. Larger histological samples, longitudinal radiographic analyses, and/or a combined approach may help clarify these issues.

Postnatal growth of the chimpanzee (*Pan troglodytes*) zygomatic bone. PELAJI S. KYAUKA, Modesto College, Behavioral Science, Modesto, CA 95368

The pattern of postnatal growth and sexual dimorphism in whole skulls of *Pan troglodytes* are documented, but studies focused on individual cranial bones, e.g., zygomatic bones are limited. This study investigates postnatal growth and sexual dimorphism in zygomatic bones of immature skulls (N=45) of *Pan troglodytes* ranging from infant to juvenile. Four linear measurements, 1) zygomaticomaxillary length, measured between zygoorbitale and zygomaxillare, 2) orbital length, measured between frontomale orbitale and zygoorbitale, 3) anterior length, measured between frontomale temporale and zygomaxillare, and 4) temporal length, measured between frontomale temporale and the tip of the zygomatic temporal process were analyzed to ascertain the growth pattern and sexual dimorphism.

The results indicate that the means of the zygomaticomaxillary, anterior and temporal lengths of female infants exceed those of male infants, but the sex differences are insignificant at $p < 0.05$. At the juvenile stage, male means surpass those of females, but a significant sex difference is observed only in the temporal length. The highest growth percentages between male infants and juveniles occur in the zygomaticomaxillary length (35.19%), temporal length (31.7%), and anterior length (30%), whereas the smallest growth percentage occurs in orbital length (12.6%). The highest growth percentages between female infants and juveniles occur in zygomaticomaxillary length (26.2%), anterior length (19.3%) and orbital length (14.6%). The smallest percentage increase occurs in temporal length (13.5%). The higher growth percentages in zygomaticomaxillary length may be explained by the fact that the zygomaticomaxillary length is part of the splanchnocranial complex.

Results of comparisons of males and female reveal that juvenile female means expressed as percentages of juvenile male means range between 93.66% and 99.47%, with an average of 97.18%. These percentages indicate that only the temporal length (93.66%) has a sexual difference greater than 5%. The result suggest the females show the least growth increase between infant and juvenile stages in the four dimensions. This observation is indicative of a faster growth rate in the male zygomatic bones which can be considered to be a functional adaptation.

Frequencies of accessory bones in the human foot. J.H. LACOBoulos, Neumann College, Aston, PA 19014-1298 and A.M. BURROWS, School of Physical Therapy, Slippery Rock University, Slippery Rock, PA 16057.

Accessory bones of the foot are islands of bone either separate from, articulating with, or completely fused to the

tarsals or metatarsals. Previous studies on the frequencies of accessory bones in the human foot have arrived at different conclusions, some studies finding that their occurrence is very common while some authors have reported only rare occurrence of accessory bones in the foot. Some of these discrepancies may be due to the use of archeological samples wherein some separate or articulating accessory bones may be lost or to the use of radiographs which may not reveal small bones that are hidden in standard radiographic projections. The present study uses human cadavers in order to assess the frequency of accessory bones of the foot including os intermetatarsale, accessory navicular, os calcaneus secundarius, os cuboides secundarium, os intercuneiforme, os peroneum, and the os cuneo metatarsale plantare. The feet of 17 adult human cadavers (34 total feet) were dissected to the level of bone. The tarsals and metatarsals were visually examined and scored for presence of the accessory bones under investigation. Ten of the cadavers examined had at least one accessory bone (58.8%) and a total of 15 feet had accessory bones (44%). All types of accessory bones were present at least once, except for the os cuboides secundarium and the os cuneo metatarsale plantare which were never observed. The most commonly occurring bone was the os calcaneus secundarius which was observed in eight feet, a frequency of 23.5%. These results conflict with some previous studies which have found the os intermetatarsale to be more commonly present. This discrepancy may reflect the different results produced by cadaveric samples vs. archeological and/or radiographic samples.

The fate of seeds dispersed by African apes and cercopithecines. J.E. LAMBERT, Department of Anthropology, University of Oregon, Eugene 97403.

Observations of frugivory and seed defecation can lend insight into the potential value of a primate's seed dispersal services. However, the most direct measure of dispersal effectiveness comes from monitoring post-dispersal seed fate. Linking animal behavior to seed fate and its ultimate effect on forest demography and regeneration is therefore a critical step in understanding the importance of primates in ecological communities. In this research, I use data on ape and monkey seed-handling behavior and seed fate to test two models proposed to link animal seed dispersal services, seed fate, and seedling demography: the Janzen (1970)-Connell (1971) Model, and Howe's (1989) Scatter-Clump Model.

Chimpanzees (*Pan troglodytes*) deposit seeds in large clumps, far from parent trees, while redtail monkeys (*Cercopithecus ascanius*) deposit seeds singly, close to parent trees (Lambert, 1999). I assess the impact of these differing seed-handling strategies on the fate of 8,100 seeds dispersed in Kibale National Park, Uganda. To test the Janzen-Connell Model, I examine the influence of distance removed from parent tree; the Scatter-Clump Model is tested by evaluating the impact of seed cluster density on seed fate. Distance and density effects are measured on the likelihood of seeds: having fungal attack or rodent/insect damage, being removed by rodents, germinating, or establishing as seedlings.

Seeds were monitored for 14 months between 1993-

1994. In addition to significant plant species effects, across species 37% of the seeds were attacked by fungus, 27% were damaged, and 61% were removed. Very few (2%) seeds germinated, and of these, almost half eventually died. There were both distance and density effects on seed fate. All seeds underneath parent trees were eventually killed, versus 12% survivorship in seeds removed from parent trees ($p < 0.05$). There was more fungal attack and seed predation *in situ* at higher seed density stations ($P < 0.01$), while more seeds were removed from lower seed density seed stations ($p < 0.05$).

These seed fate results suggest that while most seeds in Kibale eventually die, the patterns in which primates disperse seeds does affect the likelihood and degree to which post-dispersal factors will be influential (e.g., predator/fungal attack). Given that the "seed rain" in Kibale is many orders of magnitude larger than the monitored seed sample, these effects are likely to be influential on forest demography and regeneration. The utility of standard seed dispersal models will be discussed in light of information on primate frugivory.

Ridge breadth comparison between humans and koalas: does dermatoglyphic similarity imply functional similarity? K.M. LAMBERT and M. HENNEBERG, University of Adelaide, Adelaide 5005 Australia.

Presence in koalas of fingerprint patterns similar to those of humans has been recently reported. Some koala fingertips have triradii, loops and arches somewhat similar to those of humans. Scanning electron micrographs ($\times 167$) indicate that gross morphology of single dermal ridges of koalas is similar to that of humans. Interspecific comparisons of ridge breadth, in addition to traditional dermatoglyphic analyses, may provide useful insights into the origins of human variability in dermatoglyphic traits and shed light on functional significance of ridged skin. Prints from 65 adult male and 34 adult female koala hands and feet were collected. Ridge breadth was calculated using the method described for humans by Cummins and Midlo (1961). No significant differences between manual and pedal ridge breadths were found. Similarly there were no differences between antimeres. Manual and pedal ridge breadths of right and left hands, and right and left feet respectively are significantly correlated. An average breadth of a male koala ridge is 0.54mm ($s=0.06$) and of a female 0.48mm ($s=0.06$). Difference between males and females is significant. Human average ridge breadths vary, depending on author, from about 0.39mm to 0.45mm. Although some of these values can differ significantly from koala averages, the human-koala difference does not seem to be actually large when compared to that between humans and e.g. possums (0.15mm). Despite almost tenfold difference in body weight between humans and koalas their dermal ridges have similar breadths. This similarity of koala and human ridge breadths raises questions regarding occurrence of similar ridge breadths in separate lineages. Some

commonality of function related to surface contact properties or tactile acuity may be responsible.

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Violent injury and death in a Pueblo II-III sample from the southern piedmont of Sleeping Ute Mountain, Colorado. P.M. LAMBERT, Utah State University, Logan, UT 84322-0730.

Traumatic injuries in human skeletal remains from small Pueblo II-III (A.D. 1075-1280) habitation sites in Cowboy Wash on the southern piedmont of Sleeping Ute Mountain, Colorado, provide compelling evidence for serious strife among the Anasazi of the Mesa Verde region. Club wounds, scalping, decapitation, and corpse mutilation are all evident in these remains. The temporal distribution of traumatic injuries suggests that interpersonal violence, while present throughout this 200-year period, became more lethal and virulent around A.D. 1150 and thereafter. Reports of contemporaneous cases of violent injury and death at other sites in the region are evidence that these violent interactions were not isolated incidents, but rather, were part of a broader cultural phenomenon. This interpretation is supported by settlement data from the greater northern San Juan Basin, which indicate a growing concern with defense after A.D. 1150. The osteological data thus support a hypothesis that the Mesa Verde region became an increasingly difficult and dangerous place to live during the time period under investigation, and provide important insights into the causes of its final abandonment around A.D. 1280.

Fetal growth patterns: Responsivity and adaptation M. LAMPL, Dept. of Anthropology, Emory Univ., Atlanta, GA., D.E. WALRATH, Dept. of Anthropology, Univ. of Pa., Phila., PA., P. JEANTY, Vanderbilt Univ., Nashville, TN.

While much has been written about correlations between birthweight and adult morbidity, the fetal programming hypothesis has faced considerable controversy. Many of the unresolved questions concern the mechanisms by which physiology and anatomy during intrauterine life are shaped such that the body is designed to be at-risk for the cadre of correlated adult-onset diseases. Fetal outcome variables, such as birth weight, have been used to imply possible in utero processes in

lieu of actual descriptive data due to the scarcity of longitudinal data documenting human intrauterine development.

170 weekly measurements of fetal parameters (including limb length, head dimensions, chest and abdominal circumference, and organ dimensions) have been investigated for the growth patterns of 30 fetuses between 20 and 32 weeks of gestation. Parental weight, height and pre-pregnancy body mass index (BMI), maternal parity and smoking are investigated for their effects on these growth patterns.

These data permit the description of previously undocumented whole body growth rhythms and relationships. Parental variables provide insight into growth responsivity to genetic and nutritional influences: Paternal height and maternal BMI significantly influence limb growth patterns in both timing and amplitude of growth, with differential effects on limb segments.

Maternal smoking during pregnancy has two primary effects in this sample: 1. Negative effects on growth of the lower limbs; 2. Positive effects on fetal cardiac volume. These observations suggest a physiological adaptive strategy based on fetal blood flow patterns and provide one of the first data sets to suggest a mechanism for the reported associations between fetal growth and adult disease risk.

Human reproduction, the evolution of the brain, and fat storage. JANE B. LANCASTER, Department of Anthropology, University of New Mexico, Albuquerque, NM 87131

Human reproductive development and the establishment of fecundity is closely linked to the storage of energy in the form of reproductive fat unlike nonhuman primates which tend toward a pay-as-you-go reproductive strategy. This is particularly puzzling since a key feature of the human adaptation is food-sharing and the provisioning of juveniles and reproductive females. Differences will be presented in the developmental programs of human and nonhuman primate females, and in gestation and lactation from the perspective of nutritional support and risk. Unlike humans, nonhuman primates experience continued growth after puberty and during first pregnancy and lactation. In contrast, humans stop growing and store energy in fat before first pregnancy and lactation. Tribal societies further this process with seclusion and feeding of post-menarcheal girls before marriage. Special features in growth of the human infant brain during lactation are noted.

Relationship of diet and activity in Spanish Florida: isotopic and structural concordance. C.S. LARSEN, University of North Carolina, Chapel Hill, NC 27599-3120, C.B. RUFF, Johns Hopkins University Medical School, Baltimore, MD 21205, D.L. HUTCHINSON, East Carolina University, Greenville, NC 27858-4353, and M.J. SCHOENINGER, University of Wisconsin, Madison, WI 53706.

Stable isotopic and cross-sectional geometric analyses are powerful tools for identifying patterns of diet and activity in past populations. Little attention has been given to the relationship between these variables within archaeological settings. The present investigation compares stable isotope ratios (carbon and nitrogen), long bone size (length), and cross-sectional diaphyseal geometry (J , I_x/I_y) within the same individuals in order to identify patterns of diet and behavior, respectively, in prehistoric and historic-era agriculturalists in Atlantic coastal native populations (Georgia and Florida).

Regression analysis reveals several links between diet and skeletal morphology. First, for both males and females, $\delta^{13}\text{C}$ values are negatively correlated with femoral midshaft I_x/I_y ratios. High I_x/I_y ratios (>1.0) reflect greater mobility (e.g., long distance travel), thus suggesting that members of the population who ate relatively less maize were more mobile. Second, for both sexes, high $\delta^{15}\text{N}$ values are positively correlated with I_x/I_y , indicating that individuals who ate greater amounts of marine foods were relatively mobile in comparison with other members of the population. Finally, female—but not male—femoral length shows strong positive correlation with diet in historic-era agriculturalists: females with longer femora tend to have relatively low $\delta^{13}\text{C}$ values, reflecting less maize in their diets.

These findings are consistent with the general notion that farmers are more sedentary than foragers. For this setting, women who ate less maize had larger body size, which may reflect better nutrition than women who ate more maize during their juvenile years.

Supported by the National Science Foundation, St. Catherine's Island Foundation, and the University of Florida Institute for Early Contact Period Studies.

Physical performance and body size among Australian aboriginal children and adolescents from the Central Desert. M. LAVELLE, University of Rhode Island, Kingston, RI 02881 and M. HENNEBERG, University of Adelaide Medical School, Adelaide, SA 5005, Australia.

The Warlpiri community of Yuendumu is located approximately 290 kilometers NW of Alice Springs, NT. During the 1960-1970's the settlement was the focus of a longterm investigation of child growth and adolescent development by the University of Adelaide dental school, thus providing a rare baseline for future longitudinal research on biocultural and health-related

accommodation to rapidly changing socioeconomic conditions.

During the summer of 1999 the Yuendumu Collaborative Longitudinal Project made an initial visit to the community and collected anthropometric and health data on children, adolescents and adults including measures of body size and physical performance.

The results from this first year show that Yuendumu children of all ages are significantly smaller in body size than contemporary non-aboriginal school children from Melbourne (1992-1995) and perform less well on tests of grip strength, reaction time and heart rate recovery after exercise. However, comparative data on weight-for-height and subcutaneous skinfolds indicate that undernutrition may not be as important in shaping the growth of children in this population as chronic bouts of infection. Physical performance measures are highly correlated with muscle mass and are also functionally related to cross-sectional area of muscle estimated from the upper arm.

These initial results indicate that reduced growth rates in this aboriginal community, including both skeletal and muscle compartments, may result in long term, if not permanent, effects on physical performance throughout the life cycle.

This project was supported in part by grants from the Australian Research Council International Exchanges, the Dept of Anatomical Sciences of the University of Adelaide Medical School, the University of Rhode Island Foundation and URI Faculty Fund.

The unique lacrimal bulla within the nasal complex of gorillas: An accessory paranasal sinus?

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In humans, primates and other mammals the conduit for transfer of fluid secreted from the lacrimal gland to the nasal cavity is the *nasolacrimal duct* (NLD) that is located within the bony-walled nasolacrimal canal (NLC). Aside from serving as a tear conduit, the respiratory mucosa within this narrow channel has been shown to serve auxiliary secretory and absorptive functions (Paulsen et al., 1998) which include goblet cells, serous glands, microvilli and ciliated epithelia. In 1902, Sir Arthur Keith commented on a perplexing morphology of this region that was exhibited only in the gorilla nasal region. It was observed that a highly inflated NLC, termed the nasolacrimal bulla (NLB), utilized an extensive portion of the space that would normally be occupied by the maxillary sinus (MS) in all other species. Subsequently, a number of notable German investigators also described the NLB within the nasal complex of gorillas (e.g., Bolk, 1917; Aichel, 1934; Wegner, 1936). In fact, Wood-Jones (1938) mistakenly noted that the gorilla did not even manifest a maxillary sinus.

This study used CT imaging to quantify volumes of the NLB and MS in adult *Gorilla gorilla* (n=4). Quantification was performed with multiplanar reformatting and virtual 3D reconstructions based on CT scans obtained with GE HiSpeed

Advantage and Siemens DTR scanners using helical fast track evaluation. In adult gorilla skulls, the NLB occupied 36-43% of the space within the maxillary bone that would normally be occupied by the maxillary sinus.

In human groups with platyrrhine type external noses, tube-shaped nares produce laminar airflow directed more toward the inferior meatus than leptorrhine noses that primarily involve the middle meatus. As a consequence, the similar platyrrhine type nose, present also in gorillas, gave rise to increased nasal ventilation. This may have resulted in dilation of the NLB producing an accessory chamber having the dual function of processing inspired air as well as conduction of lacrimal outflow. Further, histologic evidence observed in this organ suggests a function beyond that of a passive conduit for lacrimal outflow but instead, active conditioning of inspired air.

Work supported by NSF, NIH and NYCEP

The Effect of Tourism-Led Development on the Nutritional Status of Yucatec Mayan Children. T.L. LEATHERMAN, Department of Anthropology, U. of South Carolina, Columbia, S.C. 29208, J.T. STILLMAN and A.H. GOODMAN, Natural Science, Hampshire College, Amherst, MA 01002.

"Development" in its many forms is often thought to improve economies and living conditions in impoverished regions. However, the consequences for the lives of the rural poor are less certain. For example, shifts toward a greater reliance on wage work and commercial agriculture have led to both an increase and a decrease in nutritional status of children from small-scale farming households.

Little is known about the dietary and nutritional consequences of tourism-led development, such as is taking place in the Yucatan Peninsula. The purpose of this paper is to evaluate changes in nutritional status over the last two decades in Yalcoba, a Mayan community located in the interior of the Yucatan. We report on changes in growth between surveys of schoolchildren ($n > 800$) conducted in 1987 and 1998 and rates of enamel hypoplasias in younger and older schoolchildren ($n = 455$). The enamel defects of a sixteen year old in 1998 developed between ca 1982 - 1986, whereas those of a six year old developed a decade later (1992 - 1996).

While the children of Yalcoba remain well below NCHS standards, in the eleven years between surveys the heights of age-matched boys and girls increased by an average of 2.6 and 2.9 cm, respectively. This rate of *in situ* increase of greater than one inch per decade is comparable to the increased heights of Mayans from Guatemala who now live in the U.S.A.. The frequency of enamel defects also rapidly declined over a decade: greater than 80% of older children have a paired enamel defect, compared to 30% of younger children.

These results support a secular improvement in childhood nutritional status between the early 1980s and early 1990s. Further work will be aimed at evaluating the processes by which tourism-led development has affected local conditions in Yalcoba, and potentially contributed to a net improvement in childhood nutritional status.

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Observations on the orbital groove in South African blacks. G.T. LEBONA and A.I. EJORH, Department of Human Anatomy, Medical University of Southern Africa, Medunsa 0204, South Africa

Low (1946), in describing an anomalous middle meningeal artery, referred to a groove in the lateral wall of the human orbit. According to Royle (1990) the orbital groove provides a route for an anastomosis between the middle meningeal and infraorbital arteries. Diamond (1990), however, showed it to be an artefact produced by an abrupt thinning of bone. Incidences ranging from 8.5-45% have been reported in various racial groups. This study was undertaken to obtain a comparative data in a black South African population sample.

A total of 340 dried, adult skulls used for undergraduate teaching were examined with respect to the presence of the orbital groove and its origin, course and character.

The groove was found in 216 of the 680 orbits (31.8%), representing 156 individuals (45.9%). A distinct cleft ran vertically across the orbital plate of the greater wing of the sphenoid in varying degrees of depth, width and length from the lateral extremity of the superior orbital fissure to the posterior end of the inferior orbital fissure. In 2 cases (1.8%), the groove commenced at a foramen meningo-orbitale. Each groove was continuous with that made by the orbital branch of the middle meningeal artery. Of the 156 skulls, 60 (38.5%) had a bilateral groove, 72 (46.1%) showed it on the right side and 24 (15.4%) on the left.

At 45% (45 of 100 orbits), the incidence of the orbital groove is highest among Brazilians (Santo Neto *et al.*, 1984). When viewed against published data, our overall rate of 31.8% accords well with 34.4% (22 of 64 orbits) reported in the United Kingdom (Royle, 1973), but considerably higher than the 8.5% (4 of 47 orbits) found in North Americans (Diamond, 1990). The morphological characteristics demonstrated in this study correlate in part with those in previous reports. The most significant finding, however, was the simultaneous presence of a groove in the orbit and in the middle cranial fossa which were found to be continuous. This consistent feature supports the hypothesis that the orbital groove may serve as a conduit for an arterial shunt. A need to carry out further studies in cadaveric material is emphasized.

Nonmetric variation of the sustentaculum tali and the incidence of arthritis as a measure of joint stability in the ankle. C. LEE, Department of Anthropology, Arizona State University, Tempe, Arizona 85287-2402.

Nonmetric studies of the sustentaculum tali have concentrated mainly on facet variation, with little

exploration of its effect on ankle function. This study analyzed the relationship between sustentaculum tali facet morphological variation, and subtalar joint stability, as measured by the range of motion between the talus and calcaneus, and the presence of traumatic arthritis in the subtalar joint. The calcanei in this study are from prehistoric Native American remains housed at Arizona State University. The majority of the calcanei (76) were from sedentary Southwest Pueblo sites, with a few calcanei (6) from nomadic California sites. Only adult calcanei were scored. Three variations of sustentaculum tali facets were recorded. Type A consisted of one long continuous anterior and medial facet. Type B had two distinct facets separated by a groove. Type C sustentaculum tali had only the medial facet present.

Type A sustentaculum tali was the most common facet type (59%) found, with the largest average range of joint mobility (142°), and the highest incidence of traumatic arthritis (23%). Type B sustentaculum tali was the second most common facet type (38%) present, with a lower average range of joint mobility (132°), and 19% of the calcanei affected with arthritis. Type C sustentaculum tali made up only 4% of the total sample, with the lowest average range of joint mobility (125°), and no incidence of arthritis (0%). In this study, the type A facet was the least stable, allowing more movement (flexibility) of the subtalar joint, possibly predisposing this type of ankle to abnormal pronation and supination (trauma). The type B facet configuration of the sustentaculum tali had a smaller range of movement between the calcaneus and talus, seeming to better protect the subtalar joint from accidental trauma. While the results support that type C formed the most stable subtalar joint, this result should be read with caution due to small sample size (n=3). The preliminary data support the hypothesis that nonmetric variation in the sustentaculum tali can affect subtalar joint stability.

Effects of age and gender on the frequencies of spondylolysis and *spina bifida occulta* in a skeletal collection from Golovin Bay, Alaska. S.S. LEGGE, Department of Anthropology, University of Alaska Fairbanks, AK 99775.

It has been suggested that the occurrence of spondylolysis is dependent on both gender and age. This study determined the frequency of spondylolysis in a skeletal population from Golovin Bay, AK in relation to gender and age differences. Spondylolysis was characterized only in individuals with complete lumbar regions (n=52). The overall frequency for this population is 46.9%. No statistical differences were found between males and females, and the frequency was independent of age.

Possible causes for spondylolysis include a genetic predisposition for

lysis or microfractures from repetitive stresses on the lower back (see review Newell, 1995). I compared the occurrence of spondylolysis in the Golovin Bay skeletal collection with published findings for circumpolar and non-circumpolar groups with the assumption that populations relying on similar subsistence bases may encounter similar low-back stresses. The values for this population resemble those of the Eskimos of Greenland or northern Alaska more than Eskimos of southern Alaska or non-Eskimo populations. This suggests an etiology for spondylolysis based on similar lifestyles rather than genetics.

The frequency of *spina bifida occulta* was also examined because of suggestions that it is related to spondylolysis (Fredrickson et al., 1984). The frequency of *spina bifida occulta* is 12.8% in the Golovin Bay skeletal collection, and statistical analysis indicates that it is independent of spondylolysis.

Nested distribution patterns of species composition in Guyanese primates. S.M. LEHMAN, Department of Anthropology, SUNY-Stony Brook, Stony Brook, NY 11794.

One of the most perplexing problems in evolutionary biology is explaining the non-random distribution of primates. It has been hypothesized that this non-random distribution may reflect a nested pattern of species composition. In a nested subset pattern, individual species have a strong tendency to be present in all assemblages of equal or greater size than the smallest one in which they occur. There are few data on nested distribution patterns in anthropoids. A biogeographic analysis of primate community structure was conducted to determine if nestedness occurs in the primates of Guyana.

Data from 1725 km of line-transect censuses were used to determine primate species composition and distribution patterns at sixteen survey sites in Guyana. A presence-absence matrix of species composition was created. A thermodynamic measure (T) of the order or disorder apparent in the matrix was computed for the matrix.

The resulting matrix showed a strong pattern of nestedness in the distribution of Guyanese primates ($T=14.04^\circ$), and differed significantly from random species assemblages generated using Monte Carlo simulations. One primate species (*Cebus olivaceus olivaceus*) and four sites (Canje, Dubulay, Timehri, and Abary) exhibited strong idiosyncratic temperatures that departed from the total metric for the matrix. Species similarities between sites were found to be significantly but weakly negatively correlated with distance between sites ($r_s=-0.24$, $p=0.015$). The observed nestedness may be due to species extinction in western Guyana. These

extinctions may have occurred as the result of climatic variation and changes in forest area during the Pleistocene.

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Childhood milk consumption and age at natural menopause: a lifespan perspective. L.E. LEIDY and K.L. PEARCE, Dept. of Anthropology, UMASS at Amherst, 01003-4805.

The assumption that childhood nutrition is related to age at menopause is common, but largely untested due to a lack of longitudinal data. This study examines age at menopause in relation to recalled milk consumption.

Women aged 36-65 at interview were selected for a natural menopause between ages 34 and 62 (n=764) from NHANES III, 1988-1994. Milk consumption frequencies at ages 5-12, 13-17, 18-35, and 36-65 were coded as never, 1/week, <1/week, >1/week, 1/day, and >1/day. In a much smaller study of age at menopause in Puebla, Mexico, women ages 40-60 were also asked to recall milk consumption frequency between the ages of 5 and 10. Eighty women reported a natural menopause from ages 40-58 (of 229 women interviewed, summer 1999).

In the NHANES III data set, women who drank milk <1/week at ages 5-12 report an earlier age at menopause (46.5, s.d. 5.1, n=103) compared to women who drank more milk (48.4, s.d. 5.2, n=642, p<.01). The pattern is the same across all age groups. The same relationship is not shown in the smaller study from Puebla, where women who drank milk less than once per week as children (n=25) report the same age at natural menopause as do women who drank milk daily (n=49, mean ages at menopause 48.0).

Other variables considered in relation to age at menopause include smoking habits, level of education, and parity. Methodological concerns are discussed, along with a consideration of how milk consumption might alter the mechanisms that influence age at menopause.

Dynamics of canine development in baboons and mangabeys. S.R. LEIGH. Department of Anthropology, University of Illinois, Urbana.

This study investigates life history and functional correlates of canine morphology in baboons and mangabeys

through metric studies of ontogeny. Analyses focus on the socioecological significance of both canine sexual dimorphism and variation between species by sex.

Longitudinal data derived from large samples of known-age captive animals are investigated. Canine length, for both deciduous and adult teeth, is measured from the tip of the left canine to the lateral aspect of the gingiva-enamel junction. Size adjustment is based on a variety of techniques. Data are subjected to regression analyses.

Complex patterns of canine development characterize within and between species comparisons. Deciduous canines are nondimorphic, and each sex shows similar age-related size decreases through wear. Male adult canines erupt later and grow more rapidly than female canines. In contrast to baboons, male mangabeys seem to undergo a long period during which the canine tooth is absent. Later emergence rates are also lower than in baboons. Female patterns of canine development differ radically between species. Baboons show smooth and early transitions between deciduous and adult teeth, while female mangabey canines erupt later with an obvious break between deciduous and adult states.

Delayed adult male canine development clearly reflects sexual selection for bimaturism. Furthermore, canine growth patterns imply that baboon males encounter higher levels of sexual selection earlier than mangabeys. Differences in female canine development may indicate social differences between species. Specifically, the saltational pattern of female mangabey canine development may reflect the unusual mode (relative to other Old World monkeys) by which females form dominance hierarchies.

This research was supported by NSF (SBR 9707361) and the University of Illinois.

A review of the validity of the new genus *Pseudopotto* (Schwartz, 1996). B.S. LEON, Department of Anthropology, University of Massachusetts Amherst, MA 01003

A new genus in the family Loridae was recently proposed by Schwartz (1996) based on a nearly complete skeletal specimen housed at the Anthropological Institute and Museum, University of Zürich-Irchel. This specimen, AMZ 6698, was originally identified as *Perodicticus potto*, but upon examination of the specimen, Schwartz noted several "unique" characters that ultimately led him to name a new genus and species, *Pseudopotto martini*.

This paper examines the validity of this new genus, as well as its phylogenetic affinities within the Loridae. Comparative morphological data were collected on a variety of lorids.

Pseudopotto presents several peculiarities as a genus. Morphologically, *Pseudopotto* is remarkably similar to specimens of Bosman's potto, *Perodicticus potto potto*, the smallest member of the genus. The type specimen of the genus *Pseudopotto* is not a full adult and its assumed type locality is questionable. Furthermore, several features believed to be unique to this new genus are

indeed common to the aforementioned subspecies of *P. potto*, including small body size, relatively long tail, reduced maxillary M3, and reduced cervical spines. Other features considered unique to *Pseudopotto* are actually highly variable within the genus *Perodicticus* as well as within the whole subfamily Lorinae; their usefulness as characters is suspect. These features, as well as other data, suggest the type specimen of the newly proposed genus *Pseudopotto* appears to be simply a specimen of *Perodicticus potto potto*. Perhaps *Pseudopotto martini* should be dismissed as junior synonym for *Perodicticus potto potto*.

However, the magnitude of the intraspecific variability among the subspecies of *P. potto* is substantial. Further anatomical and behavioral studies may indeed dictate taxonomic realignment at the species level. This research was supported by the Statistical Consulting Center at the University of Massachusetts Amherst.

Beyond Dominance: A Theory of Power. R. J. LEWIS, Department of Biological Anthropology and Anatomy, Duke University, Durham, NC 27708

The dominance concept as it is currently defined and applied in animal behavior is problematic. Rather than "tinkering" within the current framework, a conceptual revision is proposed. What is traditionally considered dominance is actually a combination of dominance in the strict sense and power based upon other sources. Power is defined as a phenomenon where a dyadic relationship is asymmetrical and can be divided into two types: dominance and leverage. Dominance is power based upon the use (or threat) of force. Leverage is power based upon a resource that cannot be taken by force (or at least is extremely costly to take by force). Four characteristics can be used to measure power: base, means, amount, and scope. This new framework, which is based upon established research from economics, sociology, and political science, both expands and clarifies the concept of power in animal behavior.

Primate intersexual relationships are excellent for examining power dynamics because resources and services are often sex specific. For example, mating opportunities can sometimes be used by females as leverage in intersexual relationships. Mating opportunities can be traded by females in exchange for resources and services from males. However, when males have sufficient physical power (i.e., dominance), they may be able to take mating opportunities by force. In such cases, mating opportunities do not serve as a source of leverage for females.

By considering dominance as one form of power, a more complete understanding of power dynamics and their effects on animal societies can be achieved. This cross-disciplinary approach to power may also facilitate interpretations of overall social dynamics.

Supported by an NSF Graduate Fellowship.

The PM plane and the facial "block": new evidence for constraint on primate and hominid craniofacial shape. D.E. LIEBERMAN and R.C. MCCARTHY. Dept. Anthropology, George Washington University, Washington DC 20052.

How the growth of the face, cranial base and neurocranium are integrated is a major problem for understanding the phylogenetically and behaviorally important variations in primate and hominid craniofacial architecture, especially facial projection and orientation. This study examines the role in craniofacial integration of the posterior maxillary (PM) plane, which demarcates the back of the midface at its junction with the sphenoid. Is the PM plane anatomically real, how much does it constrain craniofacial shape, and do these constraints explain any differences in craniofacial shape among hominids?

After reviewing the anatomical basis for the PM plane, and the reliability and accuracy with which it can be measured, we test three hypotheses of integration using a sample of 18 anthropoid and 15 strepsirrhine species. First, we test whether the PM plane maintains a 90° angle relative to the Neutral Horizontal Axis (NHA) of the orbits in all primates throughout growth. Second, we use the PM plane to test Dabelow's hypothesis that the orbits and anterior cranial base are more highly integrated in anthropoids than in strepsirrhines. Third, we test the hypothesis that the midline anterior cranial base and floor in primates correlate highly with each other relative to the PM plane, thereby forming an integrated unit that rotates as a whole during growth.

Results indicate that there is surprisingly little variation between the PM plane and the orientation of the orbits (NHA). In addition, the mean angle between the anterior cranial base and the PM plane differs significantly from 90° in strepsirrhines but not anthropoids, supporting Dabelow's hypothesis. The anterior cranial base and anterior cranial floor, however, correlate well with respect to the PM plane in both suborders, independent of orbital configuration. The PM plane, anterior cranial base, and anterior cranial floor, therefore, form an integrated complex, a "facial block," whose orientation relative to the posterior cranial base influences cranial shape, especially in anthropoids whose orbits constrain anterior cranial base orientation. Because of this facial block, any increases in cranial base flexion limit the antero-posterior length of the nasopharynx.

The PM plane and its relation to the facial block act as a basic constraint on craniofacial shape, and may explain a number of key differences in craniofacial architecture between archaic and modern *Homo* including midfacial height, the size of the nasopharynx, and facial orientation.

Femoral bicondylar angle measurements in 3D. A. LIGATO, K.G.M. GERRITSEN and M.W. MARZKE*, Depts. of Exercise Science and Phys. Ed. (P.O. Box 870404) and Anthropology* (P.O. Box 872402), Arizona State University, Tempe, AZ 85287.

The femoral bicondylar angle (β), defined as the angle between the sagittal plane perpendicular to the infracondylar plane and the longitudinal axis of the femoral diaphysis, is related to the manner in which species walk. To date, radiographs are often used to measure β (e.g. Tardieu & Trinkaus, 1994). However, when using these techniques, the measurement is only a two-dimensional projection of the real three-dimensional angle. Projection errors in β were estimated to be up to 2.5° when an object is rotated 10° around its longitudinal axis.

Therefore, the purpose of this study was to develop a tech-

nique that can be used to a) measure the real 3D β and to b) increase the consistency of the measurements, i.e. minimizing the digitization component.

A laser scanner (M15, Cyberware, Inc., Monterey, CA) at the ASU PRISM laboratory was used to record up to 10,000 points per square inch of a distal femur's surface which was placed on a rotating disc. Each point was described as a set of x, y, and z coordinates which describe the object's exact location in space (spatial resolution 50 - 300 μm).

3D bicondylar angles of (a cast of) *A. afarensis* AL-129 ($\beta = 14.80^\circ$), humans ($n = 4$; mean $\beta = 9.35^\circ$), and chimpanzees ($n = 3$; mean $\beta = 0.51^\circ$) were reconstructed from landmarks that were digitized manually on the 3D bone surface data obtained from the laser scanner.

To increase the consistency of the measurements, the long axis of the distal femur of *A. afarensis* AL-129 was calculated by fitting a line to the 3D coordinates describing the bone with the objective to minimize the $\Sigma \text{distance}^2$ of all data points to the line. The transverse axis was calculated as a vector describing the difference between the two data points (one on each of the condyles), that were located most distally. The resulting calculated 3D β was 15.93° .

This new methodology is currently being applied to the surfaces of femora from chimpanzees, other primates, humans, and casts from several fossil species, including *A. afarensis* 288-1, and other hominids to derive clues about their potential locomotor patterns.

Acknowledgments: PRISM laboratory; Akinori Nagano

Intra- and inter-generational analyses of American facial tissue depths. G.A. LISTI, Department of Anthropology, Tulane University at New Orleans, LA 70118 and M.H. MANHEIN, Geography and Anthropology, LSU at Baton Rouge, LA 70803.

Standards of facial tissue thickness are used by forensic anthropologists and other researchers for helping to identify missing children and adults through the use of facial reconstructions, age progressions and photographic superimpositions. Recently, new data on tissue thickness at nineteen points across the face were collected *in vivo* on a modern population from southern Louisiana. These data provide information on hundreds of individuals of different ages, sexes and races. Using a subset of these data, the purposes of this study are to determine whether relationships exist in facial tissue thickness among members of the same family and to assess the effects of age, sex and race on these relationships. This paper will discuss both inter-generational (between parents and their children) and intra-generational (between siblings) relationships.

A total of 236 family pairs (including 68 mother/child and 168 sibling pairs) were analyzed using Student's paired t-tests. The relationship between children and their fathers was not assessed due to lack of participation by fathers in the study. Results suggest that facial tissue thicknesses at all points are similar between

siblings, and are significantly dissimilar at most points between parents and offspring. Although the significance in parent/child relationships vary somewhat when sex and race are considered, sibling relationships remain the same regardless of age, sex and/or race.

Various researchers have suggested that both genetic and secular influences play major roles in an individual's development and the timing of changes in the underlying bony substrate of the skull as well as the soft tissue matrix covering it. Research in the early and latter parts of this century concerning growth and development of the bony substrate in the maxillo-facial complex and facial anthropometrics, respectively, have been particularly useful for dentists and orthodontists. This study offers observations on tissue thickness in the face in light of genetic influence and can assist in a medico-legal context.

Preparing a History of the American Association of Physical Anthropologists. M.A. LITTLE, Binghamton University, SUNY, Binghamton, NY 13902 and K.A.R. KENNEDY, Cornell University, Ithaca, NY 14853

Although there are abundant sources of published and archival documentation on the history of the American Association of Physical Anthropologists, there is limited written synthesis of its more than 70 years of history (founded in 1928). Juan Comas (1969), the distinguished Mexican anthropologist, published a *Historia Sumaria de la Asociación Americana de Antropólogos Físicos (1928-1968)* that has never been translated into English, and the late Frank Spencer, who devoted his life to studies of the history of American and British physical anthropology, published several short works on the history of the AAPA. Recognizing the need for a more detailed history of the AAPA, the officers of the Association asked Frank Spencer to recommend a systematic approach to the preparation of a history of the Association. Some of the ideas represented here are those developed by Frank Spencer. Other ideas are from the authors of this abstract. The objective is to identify the sources of information with which to compile a history of the AAPA, and to develop a plan for an ongoing archive of AAPA papers.

Archival materials will be drawn from several sources: (1) the *American Journal of Physical Anthropology*, and the *Yearbook of Physical Anthropology*, where proceedings, resolutions, policy statements, constitution history, obituaries of officers of the AAPA, and other published materials may be found by systematic searching; and (2) papers from the National Anthropological Archives (Smithsonian) and other archival sites. The purpose of this activity is to: preserve records for the history of the profession; identify records for restudy and comparative analysis; chart the past and predict new trends in the field; and identify resources for the teaching of the history of biological anthropology for AAPA members.

Morphometric analysis of hominoid lower molars found in Yuanmou of Yunnan Province, China. W. LIU¹, L. HLUSKO² and L. ZHENG³, ¹Institute of Vertebrate Paleontology and Paleoanthropology, Beijing 100044, China; ²Department of Anthropology, Pennsylvania State University, University Park, PA16802; ³Provincial Institute of Archaeology, Kunming 650118, China

Since 1986, excavations at several sites in Yuanmou County, Yunnan Province, China have produced numerous fossil remains of a late Miocene hominoid. Over 1,000 isolated teeth have been recovered. These ≈ 8 myr old fossils are similar to *Lufengpithecus*, though it is unclear as to whether they represent a new taxon or not. The relationship of the Asian hominoids to the African great apes is also a subject of controversy. Our morphometric analysis of mandibular molar crown cross-sectional shape provides information pertinent to these debates.

Euclidean distance matrix analysis(EDMA) was used to investigate the cross-sectional shape of 79 unworn mandibular molars from Yuanmou. These were compared to samples of *Lufengpithecus*(n=6), gorilla(n=30), chimpanzee(n=34), and modern humans(n=26).

Our results show that the Yuanmou hominoid and *Lufengpithecus* are similar, though there are differences on the lingual side of the crown. EDMA also demonstrates that the Yuanmou hominoid is significantly different from humans in the same way as are the African great apes. However a close relationship between this 8 myr old Asian hominoid and the African hominoids cannot be confirmed until further comparisons with orangutans are made.

The Yuanmou hominoid differs the least when compared with the gorilla sample. These results suggest that gorillas and the Yuanmou hominoid display the basal hominoid cross-sectional morphology. Chimpanzees and humans have derived cross-sectional shapes.

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A comparison of permanent tooth formation in two ethnic groups (4 to 9 years) living in London, UK. H.M.LIVERSIDGE and T.SPEECHLY, St. Barts & The Royal London, QMW, Univ. of London, UK.

The aim of this study was to describe tooth formation in a non-random group of British children (n=521) of Bangladeshi and white Caucasian origin aged between 4 and 9 years. This was a cross-sectional retrospective study of radiographs of healthy patients attending a dental hospital. Developing permanent mandibular teeth were assessed from radiographs according to criteria described by Demirjian, Goldstein and Tanner (1973, *Human Biology*, 45, 211-227). Mean values for individual teeth were compared after probit analysis. Formation was also expressed relative to stages of the first permanent molar (M_1); the distribution of stages was compared with the Mann-Whitney test.

Results show few differences in the mean age of

tooth formation between these groups. The distribution of stages relative to M_1 formation showed some significant differences ($p < 0.05$) between the two ethnic groups; however, these comparisons were all of small sample size ($n < 30$). As expected, the mean age for tooth formation in girls was earlier than boys in almost all stages. When M_1 was at stages E, F and G, the canine showed significant differences ($P < 0.05$) in the distribution of stages between boys and girls.

These results suggest little ethnic difference in tooth formation for this group of children but emphasises the need for sufficient age range and sample size for any comparative study.

Establishing the polarity of temporal bone morphology in African hominoids using geometric morphometrics. C. A. LOCKWOOD¹, J. M. LYNCH^{1,2}, and W. H. KIMBEL^{1,3}, ¹Institute of Human Origins, ²Interdisciplinary Humanities Program, ³Department of Anthropology, ASU, Tempe, AZ 85287.

The hominoid temporal bone offers a complex array of morphology and is often preserved in the fossil record. It has demonstrated utility in systematics, but quantitative studies have been limited mainly to univariate comparisons. In this study we use techniques of 3D geometric morphometrics to 1) quantify differences among extant African hominoid species and 2) compare them to early hominins to establish which extant species, if any, most closely corresponds to the primitive morphotype for the hominin clade.

We chose 23 temporal bone landmarks based on repeatability and relevance to qualitative temporal bone characters commonly used in hominin systematics. Crania were digitized using a Microscribe 3D portable digitizer. Samples include 125 individuals divided equally between *Homo sapiens*, *Gorilla g. gorilla*, and *Pan troglodytes*, as well as five casts of fossil hominins, representing *Australopithecus afarensis*, *A. africanus*, *A. boisei*, and *H. habilis*.

Using the program *Morphologika* (O'Higgins and Jones, 1998), we conducted a relative warp analysis to establish interspecific differences and the bounds of intraspecific variation. This effectively discriminates among species, the major source of variation being between humans and apes. Thin-plate spline analyses show that, for example, African ape temporal bones are relatively broader mediolaterally than those of humans. The tympanic element extends farther laterally in apes, especially in gorillas. The human glenoid fossa is larger relative to the size of the temporal bone as a whole, and deeper, but the anterior portion of the articular eminence is reduced. Great ape temporal bones are also distinct from each other. Gorillas lack the extensive preglenoid surface of chimpanzees, and their mastoid processes are less medially inflected. Thus, geometric methods express and quantify features hitherto discussed from a qualitative, often subjective, perspective.

Fossil hominins are distributed roughly between the gorilla and human clusters. A.L. 444-2 of *A. afarensis* falls close to the gorilla female distribution. In addition to demonstrating that gorillas and chimpanzees are distinct in temporal bone morphology, we conclude that chimpanzees are autapomorphic in several ways and not a good model for early hominin temporal bone shape.

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